

## **Pulsed High Density Fusion**

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Based on results from recent FRC acceleration experiments, together with the confinement scaling observed in past FRC experiments, a method has been determined by which an FRC can be compressed to high density and brought to ignition conditions in a rapid, repetitive manner. This regime is referred to as the Pulsed High Density (PHD) regime of MFE. Unlike MTF, the upper boundary of this regime remains below the density limit imposed by material strength limitations from the confining field.

Considerable data has been accumulated from various FRC experiments that span over two orders of magnitude in density and an order of magnitude in radius. Given the observed scaling with size and density, the required radius at a density of  $10^{24} \text{ m}^{-3}$  for a DT fusion burn with a gain  $> 1$  is found to be  $\sim 1 \text{ cm}$ .

The method by which the plasma density and temperature can be brought to fusion conditions is to start with a much simpler, low voltage FRC plasma source that can be repetitively pulsed. The energy necessary for burn is transferred to the FRC in the form of translational energy, which is produced by an inductive magnetized plasma accelerator (IMPAC) that is also capable of repetitive pulsing. The simplicity of this approach to fusion lies in the fact that the directed energy of the FRC mass,  $E_d (= \frac{1}{2} M v_{\text{FRC}}^2)$  is much greater than the FRC internal energy ( $3/2 N k T$ ). Since  $E_d$  is in the form of a coherent translational motion, the confining magnetic fields, as well as accelerating fields, need to be no greater than required to contain the low-pressure FRC generated in the source coil ( $\sim 0.4 \text{ T}$ ). This leads to a tremendous reduction in magnet mass as well as stored energy requirements for the accelerator. The conversion of the FRC directed energy into thermal energy occurs only after the FRC has reached the burn chamber where the FRC is slowed and compressed to fusion conditions. This chamber, which has a high magnetic field ( $\sim 30 \text{ T}$ ), can be steady state and can thus be generated by a superconducting magnet. The goal of concept exploration experiment would be the construction of an IMPAC device capable of producing a FRC plasma where all key parameters can be brought to within an order of magnitude of that required for a  $Q \sim 1$  fusion burn.

The PHD fusion envisioned also provides for a simple direct conversion of the plasma into directed thrust. Of all fusion reactor embodiments, only the magnetically confined plasma in the Field Reversed Configuration (FRC) has the linear geometry, low confining field, and high plasma pressure required for the direct conversion of fusion energy into high specific impulse and thrust, and would thus have direct applicability to deep space flight.